Model-Based Enterprise Capabilities Matrix
INCOSE Challenge Team Meeting
January 2019

Joe Hale,
NASA/MSFC,
Joe.Hale@Nasa.gov

Al Hoheb,
The Aerospace Corporation,
Albert.c.Hoheb@aero.org

INCOSE
International Council on Systems Engineering

Model-Based Enterprise Capability Matrix

Challenge Team Effort

- Co-Leads:
  - *Joe Hale, NASA/MSFC, joe.hale@nasa.gov*
  - *Al Hoheb, The Aerospace Corporation/SED, albert.c.hoheb@aero.org*
- Challenge team:
  - *Federation of those willing to assist in the development and deployment of the products; now 70 and growing*
- Products:
  - *The Technical Project Plan (TPP)*
  - *The Matrix document purpose is to provide a reference for enterprise and program/project organizations to assess their current and desired implementation of modeling*
  - *The Users Guide is a role-based guide for how to use the matrix for developing a strategic vision, roadmap, apply a yardstick, and perform tactical planning*
  - *http://wiki.omg.org/MBSE/ references provide an on-line overview of the products and the Challenge team efforts*
  - *INCOSE Connect entry – not started*

Document Pedigree and Plan

- ✓Nov 2016 Aerospace MBSE Community Roadmap
- ✓Oct 2017 NASA MFSC MBSE Maturity Matrix
- ✓Nov 2017 OSD Digital Engineering Working Group – presentation and co-lead kickoff
- ✓Jan 2018 INCOSE IW Breakout **Workshop** – presentation and workshop; – 2 half day session with over 50 participants, resulted in draft INCOSE matrix version 1.0
- ✓Mar 2018 INCOSE Challenge Team Inputs -- comments
- ✓May 2018 Aerospace System Engineering Forum -- presentation and **workshop**; draft INCOSE matrix version 1.1
- ✓May 2018 USAF DE Working Group presentation – presentation, draft version 1.2
- ✓June 2018 INCOSE Challenge Team Inputs -- draft version 1.3 in, draft users guide
- ✓July 2018 INCOSE IS **workshop** -- draft version 1.3 in, draft users guide
- ✓Aug 2018 version 1.4, wiki site initially populated
- ✓Sept 2018 1.5, updated users guide
- ✓Oct 2018 OSD Cross-check against the OSD DE Strategy – all strategy elements covered
- ✓Oct 2018 NDIA SE Conference **workshop –** first fully populated matrix
- ✓Nov 2018 Presentation to MIT/LL
- Dec 2018 INCOSE Challenge Team Inputs – matrix version 1.6a
- Jan 2019 INCOSE IW Outbrief and Breakout **workshop**
- Feb 2019 Aerospace System Engineering Forum **workshop**
- TBD Draft INCOSE document approval submittal
- TBD document draft use and available to members on INCOSE Connect

The products have come a long way in a short time – one calendar year!

Would like to engage IEEE and AIAA as well

Product Status

- Model-Based Enterprise Capabilities Matrix (MBECM) INCOSE Challenge Team Technical Project Plan (TPP) version 1.3
  - *Two iterations with INCOSE; addresses latest INCOSE policy documents*
  - *Awaiting approval*
- Model-Based Enterprise Capabilities Matrix (MBECM) version 1.6a
  - *Fully populated matrix with all original inputs scrubbed to be more readable and specific*
  - *Close to the version to be brought to the Jan. 2019 INCOSE IW and workshop*
- User's Guide version 3
  - *PPTX charts*
  - *Additional concepts TBD*
    - Sample reports
  - *Glossary of terms TBD*
- http://wiki.omg.org/MBSE/ needs update
  - *references provide an on-line overview of the products and the Challenge team efforts*
- INCOSE Connect - not started

Elements of the Matrix Technical Project Plan

Model-Based Enterprise Capabilities Matrix

Problem statement and Opportunities

- Problem Statement:
  - *Organizations are implementing system engineering with increasing model based capabilities and would benefit from a reference matrix to assess their current state and plan their desired state. The Model-Based Enterprise Capabilities Matrix (MBECM) provides the reference for these types of assessments.*
- Opportunities:
  - *The Model-Based Enterprise Capabilities Matrix (MBECM) and associated User's Guide are based on original works from NASA/MSFC and The Aerospace Corporation with INCOSE providing the collaboration opportunity.*
  - *The opportunity to link and cross-check the work against systems engineering and enterprise architecture work as well as the US DoD Office of the Secretary of Defense (OSD) related to digital engineering and their published Digital Engineering (DE) Strategy enabled the products to be used at the enterprise, systems, program and project levels as well as address key roles in acquisition and development. Mapping the matrix capabilities to the ISO/IEC/IEEE 15288:2015 - Systems and software engineering standards as well as the DE Strategy has ensured proper coupling of capabilities to both processes and desired results.*
  - *In addition, the co-leads have used the opportunity to leverage NASA and Aerospace reports to define the matrix stage and cell information for the capabilities.*

Model-Based Enterprise Capabilities Matrix

Vision and Expected Outcomes

- INCOSE's Vision 2025 document, identifies "Virtual Engineering Part of The Digital Revolution" and "Integrating Model-based Approaches" as key concepts transforming systems engineering to the desired future state. This INCOSE vision can be furthered by the Matrix and User's guide.

- The Matrix and User's Guide identify a comprehensive set of model-based capabilities, that were credibly sourced, and can be used by organizations to plan the improvement of their model based enterprise capabilities. Users are encouraged to tailor the Matrix to their needs; adopting their organization language, promoting or collapsing rows based on their risks and needs, and applying it to their enterprise and programs/projects.

- Model-Based Enterprise Capabilities Matrix (MBECM) is an excel-based spreadsheet composed of descriptive model-based capability rows and columns that define the capability stage. The cells in a capability row progress from a capability that has little or no model based elements to the highest stage with the greatest amount of model based capability for an enterprise.

- The associated User's Guide describes how organizations may use the matrix as an input for strategic and tactical planning, development roadmaps, enterprise/program/project assessment, or for specific roles such as the program/project manager, system engineering, Information System lead, or modeler to plan and build their capabilities.

Model-Based Enterprise Capabilities Matrix

Stakeholders

- INCOSE Stakeholders such as the INCOSE SE Transformation group and the INCOSE MBSE Initiative. The co-leads and many of the contributors are from the U.S. space industry however the Challenge Team members cut across industries and countries. The eventual stakeholders will be INCOSE and those that use INCOSE products -- spanning industries and country affiliations.

- DoD, specifically OSD (DASD/SE) sponsored the 2018 IW breakout that led to the formation of the Challenge team and scoped the initial products. INCOSE Organization Stakeholders include the INCOSE AD Technical Information and the INCOSE Technical Director. The project leads then created a set of meeting and workshop opportunities to increase Challenge team membership, conducted Challenge Team meetings to continue to refine the scope and content of the products.

- There are high- levels of interest across OSD, DoD services, Service Centers, programs, and projects as well as across NASA Centers, JPL, the USAF, AF Space and Missiles System Center, and across industry.

- The Challenge team membership as of November 2018 was around 70.

Upcoming Workshop Opportunities

- 26-29 January 2019 INCOSE International Workshop
  - *Working session Monday 28 January, 1-3pm*

- 12-14 February 2019 Aerospace, System Engineering Forum, ”Leveraging MBSE Across the Enterprise”
  - *Open to U.S. Citizens*
  - *El Segundo, California*
  - *https://aerospace.org/events/systems-engineering-forum*
  - *Model-Based Enterprise Capabilities Matrix Workshop Tuesday 2/12, 1-4pm*

Model-Based Enterprise Capability Matrix

Monday 28 Jan. 2019 INCOSE Workshop Agenda, 1-3

10 minutes Welcome and self-Introductions, sign in sheet

10 minutes Provide an overview of the Matrix and it's Users Guide

1. *Reprise parts of plenary presentation*

60 minutes Working session

1. *Instructions for attendees*
2. *Split into groups by role; PM, SE, IT, Modeler*
3. *Round 1: Validate the role-based MBE capabilities*
   - Does each set of role-based capabilities cover what is necessary?
   - Need to use other capabilities rows outside of the role? Which ones?
   - Recommended changes to rows/cells?
4. *Round 2: Create a sample report. What would it look like? Heat map, table, etc.?*
   - Get sample results, record observations and findings

20 minutes Outbrief key findings

10 minutes Recommended actions for co-leads and INCOSE

Validate the Matrix and User's Guide Concepts

Model-Based Enterprise Capability Matrix

Workshop Questions

- What else would you need in order to bring this to your organization and use it?
- How can we share information about Matrix/User's Guide application?
- What parts of the Matrix are you uncomfortable with and what recommendations do you have?
- What else would you like to be addressed in the User's Guide?

Model-Based Enterprise Capabilities Matrix 1.6a

Snip of page matrix (page 1 of 3), blue show changes from previous version

19 November 2018

INCOSE Model-Based Enterprise Capabilities Matrix (1.6a)

Model-Based Capability Stages	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Commentary
Workforce/Culture						
MBSE Approach/Objectives	Awareness that MBSE may be used and may be beneficial	Sub-Discipline Tool use (e.g., CRADLE, DOORS)	Full System Models. Modeling results used to inform systems engineers in system analysis, design, and integration.	Full System Models; Model views translated into more traditional views for use and understanding by organization. Modeling results support decision making.	Full System Models; Organization familiar and competent in using modeling views for key system decisions	MBSE Approach/Objectives are well defined and broadly communicated to, and understood by, Engineering, Program/Projects, CIO, S&MA, etc.
Model-Based Tool Use	Not using enterperise and system level modeling tools, not covering the system life cycle	Limited use of enterperise and system level modeling tools, not covering the system life cycle	Use of specific enterprise and systems model(s) within System Engineering organizations.	Use of specific enterprise and systems model(s) within Systems Engineering organizations – understanding how external systems engineering models relate.	Use of specific enterprise and sytsems model(s) within Systems Engineering organizations across an enterprise.	Expecting different tools to be used intra/inter-Center, between Gov and Contractor, and across Contractors
SE-driven Model Building	Models are not developed for the system or enterprise engineering processes	Models are developed for parts of the system engineering or enterprise engineering processes	Full System/Enterprise Models are developed	Multiple System Models are integrated for the enterprise	Multiple enterprise models are interfaced within or across mission areas	Model structure/architecture driven by SE objectives/analyses/uses and evidentiary artifacts
Lifecycle Coverage	No models or models only address specific problems within a life cycle phase	Models cover only Single life cycle Phases	Models cover Multi-Phases; Limited Reviews	Multi-Contiguous Phases	End-to-End, Top-to-Bottom	Across all Phases and down to lowest decomposition
Institutional Adoption (e.g., agency, service, center)	Some parts of the institution have adopted (e.g., new programs/initiative, pilot programs, and business case driven)	Adoption by institution Enterprise or Systems Engineering Organizations.	Common implementation basis across institution.	Consistent institutional approach across organizations with variations as appropriate for specific needs.	Policy and practice driven across the institution.	Tools, training, and IT infrastructure provided/maintained by Institutional resources
Organizational Adoption (e.g., entrprise, program, project)	Some parts of the organization have adopted (e.g., new programs/initiative, pilot programs, and business case driven)	Adoption by organization Enterprise or Systems Engineering Organizations.	Common implementation basis across organization.	Consistent organization approach across programs/projects with variations as appropriate for specific needs.	Policy and practice driven across the organization.	Discussion about whether this is at insitutional level or at lower level
Definition of roles and responsibilities	Model-based Knowledge, Skills, and Abilities (KSAs) are completely undefined and unknown	Model-based Knowledge, Skills, and Abilities (KSAs) are defined for modelers	Model-based Knowledge, Skills, and Abilities (KSAs) are defined for roles involved with modeling; Enterprise Architect, SE, PM, IT, modelers, etc..	Model-based Knowledge, Skills, and Abilities (KSAs) are defined for roles involved with enterprise management	People who need to be active are identified and involved. Sufficient staffing and staffing plan ensures all roles are fulfilled.	Moved up from Processes/Methodology. Will be dependent on where you are in the organization
Modeling Development Skills	None, or ad-hoc for all staff	Modeling of components of the Enterprise or System.	Novice Modellers on full Enterprise or System – subsystem models.	Expert Model development lead with experience practicing modeling on at least 1 project that successfully completed at least 3 major technical reviews that used models in support of the review.	Expert Model development lead that sets modeling standards and evaluates the model product quality of other modelers	More than just modeling tool expertise. This includes expertise in model structure/architecture that supports all subsequent uses
Modeing Use skills	None, or ad-hoc for all staff	Can generate tool standard digital artifacts as needed to evaluate the Enterprise or System.	Can generate tool custom digital artifacts as needed to evaluate the Enterprise or System.	Can generate custom digital artifacts across tools, models, and data sets to evaluate the Enterprise or System.	Can contribute to defining the enterprise, system, and other data needed by the complete team to perform analysis for IPTs, reviews, audits, and other technical and programmatic decisions.	This covers a role that all government team members must have to conduct model based acquisition
Modeling-related Training/KSA development	No training	Modeling on specific tools with respect to their role as a user or modeler	Training and initial experience to perform their modeler or user roles.	Demonstrating role capabilities using the models, coaching and instructing others	Provide leadership in proposing, designing, and delivering training that is appropriate for the modeling and user roles	Multilevel training series, including "hands-on" real world(-like) execution. Paul Walter to help flesh this section out
Common Language	System terminology defined for the project or program.	Common Glossary/Data Dictionary	Top Tier Ontology is defined for the enterprise.	Discipline Ontologies	Common, tiered taxonomies/ontologies is defined and consistent with accept community standards.	A hierarchy of taxonomies and ontologies: Generic Upper Level with subordinate domain/discipline Lower Levels. Was Data Structures row, moved up from Tools & IT Infrastructure
SE Processes/Methodology						
						This is a rollup of 6.1.1 and 6.1.2. Mariiy Users may want to replace this

Fully populated matrix – ready for pilot use!

User Guide Outline

- Overview
- Developmental History (abbreviated)
- Matrix Structure
- User Roles and Examples of Relevant Attribute Scope & Domains
- Matrix Uses:
  - *Strategic Vision*
  - *Roadmap*
  - *Yardstick*
  - *Tactical Planning*
- Tailoring
  - *Use language that is important to the organization*
    - E.g., NASA uses “project,” DoD uses “Program”
  - *Identification of individual SE processes to be addressed that are critical to success*
    - E.g. CM/DM
  - *Addition/deletion of rows to focus on organization perspective*

See separate User’s Guide document for contents

INCOSE Model-Based Enterprise Capabilities Matrix

User Guide

Contents

- Overview
- Developmental History (abbreviated)
- Matrix Structure
- User Roles and Examples of Relevant Attribute Scope & Domains
- Matrix Uses:
  - Strategic Vision
  - Roadmap
  - Yardstick
  - Tactical Planning
- Tailoring

Overview

- The INCOSE Model-Based Enterprise Capabilities Matrix is intended to be a tool to help Organizations, that have already made the decision to implement digital or model-based capabilities, to assess and grow these capabilities in a comprehensive and coherent manner.
- The scope of the Organization under regard may the the entire Enterprise or any sub-component within an Enterprise.
- Depending on a Stakeholder/User role, the entirety of the Matrix or selected subsets may be employed.
- The purpose of this Guide is to give the User some guidance on how to use the Matrix for the following purposes:
  - Strategic Vision
  - Roadmap
  - Yardstick
  - Tactical Planning
- The Matrix is intended to serve as a starting point for the various uses. In most cases, the wording and level of detail will be tailored for specific applications and Organizations
- The Guide begins with an abbreviated Developmental History and an explanation of the Matrix structure
- The Guide next identifies selected types of User Roles with some examples of relevant attribute scope & domains. This is by no means an exhaustive listing
- Next are the four Matrix Uses. Each includes
  - The Objective
  - The General Approach
  - An Example

Developmental History (abbreviated)

- The story begins with two independent efforts to provide a reference for enterprise and program/project organizations to assess their current and desired implementation of modeling
  - The Aerospace Corporation MBSE Community Roadmap
  - NASA MSFC MBSE Maturity Matrix
- Following a presentation of both at the OSD Digital Engineering Working Group, it was decided to combine these efforts to develop a comprehensive **Model-Based Enterprise Capability Matrix**
- Early drafts of the Matrix were presented at a series of Workshops at various System Engineering fora:
  - INCOSE International Workshop (Jan 2018) where an **INCOSE Challenge Team** was formed to produce a candidate INCOSE product
  - Aerospace System Engineering Forum (May 2018)
  - INCOSE International Symposium (July 2018)
  - NDIA SE Conference workshop (Oct 2018)
  - INCOSE International Workshop (Jan 2019) where the final version of the Matrix and a User's Guide is expected to completed
- **INCOSE Challenge Team** includes Reps from numerous Organizations, including:
  - Various NASA Centers
    - LaRC, GRC, GSFC, MSFC, JPL, JSC
  - The Aerospace Corporation
  - Office of the Secretary of Defense (OSD)
  - Space and Naval Warfare Systems Command (SPAWAR)
  - US Navy
  - US Air Force
  - National Defense Industrial Association (NDIA)
  - National Institute of Standards and Technology (NIST)
  - Airbus
  - Lockheed Martin
  - Japan Aerospace Exploration Agency (JAXA)
  - Raytheon
  - Harris Corp.
  - Northrup-Grumman
  - Booz Allen Hamilton
  - BAE Systems
  - General Atomics
  - Draper
  - Ford
  - Boeing
  - Dassault Systemes
  - Mitre
  - MIT
  - Thales
- The **Challenge Team** is co-Led by
  - Al Hoheb – The Aerospace Corporation
  - Joe Hale – NASA/MSFC

Matrix Structure

- Rows: Range of Model-Based Engineering factors/attributes, grouped by areas, that directly or indirectly support/enable across the enterprise
  - *Workforce/Culture, SE Processes/Methodology, Program and Project Process/Methodology, Model-Based Effectiveness, Tools and IT Infrastructure, Project Use, Policy*
- Columns: Increasing Stages of Capability
  - *Left-most column reflects non-MBSE/MBE Capabilities (i.e., Doc-centric)*
  - *Right-most column reflects fully mature MBSE/MBE Capabilities*
  - *Intervening columns reflect increasing, incremental Stages of Capability for each particular factor/attribute (row)*

Attributes	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4
Attr1					
Attr2					
Attr3					
Attr4					

User Roles and Examples of Relevant Attribute Scope & Domains (example)

User Roles	Workforce/ Culture	SE Process Methodology	PM Process Methodology	Toos and IT Infrastructure	Model Based Effectiveness	Project Use	Policy
Enterprise manager	x	x	x	x	x	x	x
Project/Program manager	x		x			x	x
System Engineer	x	x			x	x	x
Tool curator		x	x		x		
IT representative	x			x		x	x
Functional specialist		x			x		
HR	x					x	x
Training	x	x	x	x	x	x	x

Matrix Uses: Strategic Vision

- Objective: Define a future state description of one or more domains/attributes of a mature Model-Based Enterprise
- General Approach: Derive a tailored vision based on the most relevant mature attribute descriptions in the left-most column.
- Example: Selected *Tools & IT Infrastructure* attributes are the relevant attributes for this example

Model-Based Capability Stages	**Stage 0**	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**
Tools & IT Infrastructure					
Collaboration	E-mail, telecom.	System Model File Exchange.	Various organizations working on different parts of model. Full model integrated by a single organizations.	Partial On-line, real-time collaboration amongst distributed teams	On-line, real-time collaboration amongst distributed teams
Disparate Database/Tool interoperability	None	Tool-to-Tool, ad hoc interoperability	Partial Federated Database Management System (FDBMS)	Main tools interoperable. Supporting tools interact through file transfer.	Fully Federated w/ standard "plug-and-play" interfaces. Data is interchanged among tools
Inter-Database/Tool Data Item Associations	Databases/tools are independent	Inter-Database/Tool Data Item associations defined	Inter-Database/Tool Data Item associations defined, captured, managed	Inter-Database/Tool Data Item associations among all data items defined, captured, managed, and traceable	Inter-Database/Tool Data Item associations among all data items defined, captured, managed, and traceable where changes in one data source alerts owners of other data sources of intended updates
User IF, Viewpoint/Views	N/A	Doc Gen	UI draws from Model app	UI draws from multiple models/DBs	UI supports Interrogation; multiple configs

  - The Stage 4 column gives the mature attribute descriptions for the relevant attributes
  - A Vision statement might be:
    - **We aim to provide a fully Federated IT architecture with:**
      - **Standard "plug-and-play" interfaces**
      - **Managed data item relationships across heterogenous, disparate data sources**
      - **User Interfaces that enable navigation and interrogation across heterogenous, disparate data sources, and**
      - **On-line, real-time collaboration amongst distributed teams**

Potential Purposes/Uses for Strategic Visions

[Source: National Defense University]

- Help to describe an organization's purpose; a declaration of an organization’s objectives; can help guide its internal decision-making
- Provides a picture of the future. It bridges the present and the future. The right vision takes the organization out of the present, and focuses it on the future.
- It attracts commitment and energizes people. This is one of the primary reasons for having a vision for an organization: its motivational effect.
- Serve as foundations for a broader strategic plan.

Matrix Uses: Roadmap

- Objective: Define a Roadmap of increasing capability of one or more domains/attributes towards a mature Model-Based Enterprise
- General Approach: Derive a tailored roadmap based on one or more relevant attribute rows.
- Example: Selected *Tools & IT Infrastructure* attributes are the relevant attributes for this example

Model-Based Capability Stages	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4
Tools & IT Infrastructure					
Collaboration	E-mail, telecom.	System Model File Exchange.	Various organizations working on different parts of model. Full model integrated by a single organizations.	Partial On-line, real-time collaboration amongst distributed teams	On-line, real-time collaboration amongst distributed teams
Disparate Database/Tool interoperability	None	Tool-to-Tool, ad hoc interoperability	Partial Federated Database Management System (FDBMS)	Main tools interoperable. Supporting tools interact through file transfer.	Fully Federated w/ standard "plug-and-play" interfaces. Data is interchanged among tools
Inter-Database/Tool Data Item Associations	Databases/tools are independent	Inter-Database/Tool Data Item associations defined	Inter-Database/Tool Data Item associations defined, captured, managed	Inter-Database/Tool Data Item associations among all data items defined, captured, managed, and traceable	Inter-Database/Tool Data Item associations among all data items defined, captured, managed, and traceable where changes in one data source alerts owners of other data sources of intended updates
User IF, Viewpoint/Views	N/A	Doc Gen	UI draws from Model app	UI draws from multiple models/DBs	UI supports Interrogation; multiple configs

- Roadmap for tool interoperability and traceability:
  - Milestone 1: Some tool-to-tool integration; cross-tool data associations defined
  - Milestone 2: Demonstration of selected tools in a Federated Architecture; cross-tool data associations defined, captured, managed
  - Milestone 3: Main tools interoperable in a Federated Architecture; cross-tool data associations defined, captured, managed, and traceable
  - Milestone 4: All tools interoperable in a fully Federated Architecture; cross-tool data associations defined, captured, managed, and traceable

Potential Uses of a Roadmap

[source: Wikipedia]

- Provides a flexible planning technique to support strategic and long-range planning, by matching short-term and long-term goals with specific technology solutions
- Has three major uses:
  - It helps reach a consensus about a set of needs and the technologies required to satisfy those needs,
  - It provides a mechanism to help forecast technology developments, and
  - It provides a framework to help plan and coordinate technology developments.

Matrix Uses: Yardstick

- Objective: Define a method of characterizing the current capability of one or more domains/attributes for a Model-Based Enterprise
- General Approach: Assess the current Stage of Implementation by the Organization for one or more relevant attributes. Highlight the attained Stage of Implementation cell and all calls to the left of the attained Stage for all assessed relevant attributes.
- Example: Selected *Tools & IT Infrastructure* attributes are the relevant attributes for this example

Model-Based Capability Stages	**Stage 0**	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**
Tools & IT Infrastructure					
Collaboration	E-mail, telecom.	System Model File Exchange.	Various organizations working on different parts of model. Full model integrated by a single organizations.	Partial On-line, real-time collaboration amongst distributed teams	On-line, real-time collaboration amongst distributed teams
Disparate Database/Tool interoperability	None	Tool-to-Tool, ad hoc interoperability	Partial Federated Database Management System (FDBMS)	Main tools interoperable. Supporting tools interact through file transfer.	Fully Federated w/ standard "plug-and-play" interfaces. Data is interchanged among tools
Inter-Database/Tool Data Item Associations	Databases/tools are independent	Inter-Database/Tool Data Item associations defined	Inter-Database/Tool Data Item associations defined, captured, managed	Inter-Database/Tool Data Item associations among all data items defined, captured, managed, and traceable	Inter-Database/Tool Data Item associations among all data items defined, captured, managed, and traceable where changes in one data source alerts owners of other data sources of intended updates
User IF, Viewpoint/Views	N/A	Doc Gen	UI draws from Model app	UI draws from multiple models/DBs	UI supports Interrogation; multiple configs

- Color coding can be used to provide additional status, e.g.,
  - Green indicates attribute capability is operational
  - Yellow indicates attribute capability in active development

Potential Uses of a Yardstick

- Provides a easily understandable, graphical method to present:
  - The current Stage of Implementation across a variety of attributes
  - Using different color-coding, the state of activity to advance the Stage of Implementation of an attribute, e.g.,
    - Planned Activities
    - Activities Underway (may include different color-coding to reflect status of the activity w.r.t. schedule, budget, &c.)

Matrix Uses: Tactical Planning

- Objective: Given the current capability of one or more domains/attributes of a Model-Based Enterprise, determine on which domain(s)/attribute(s) to apply effort/resources to advance in the near-term
- General Approach: Starting with the attained "Yardstick" assessment of one or more relevant attributes, determine which attribute capabilities to be advanced in the budget cycle of interest. A factor to consider, in addition to resources constraints, might include possible dependencies between attributes. For example, allocating resources to advance Attribute A may not make sense without first advancing an enabling or precursor attribute.
- Example: Selected *Tools & IT Infrastructure* attributes are the relevant attributes for this example

Model-Based Capability Stages	**Stage 0**	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**
Tools & IT Infrastructure					
Collaboration	E-mail, telecom.	System Model File Exchange.	Various organizations working on different parts of model. Full model integrated by a single organizations.	Partial On-line, real-time collaboration amongst distributed teams	On-line, real-time collaboration amongst distributed teams
Disparate Database/Tool interoperability	None	Tool-to-Tool, ad hoc interoperability	Partial Federated Database Management System (FDBMS)	Main tools interoperable. Supporting tools interact through file transfer.	Fully Federated w/ standard "plug-and-play" interfaces. Data is interchanged among tools
Inter-Database/Tool Data Item Associations	Databases/tools are independent	Inter-Database/Tool Data Item associations defined	Inter-Database/Tool Data Item associations defined, captured, managed	Inter-Database/Tool Data Item associations among all data items defined, captured, managed, and traceable	Inter-Database/Tool Data Item associations among all data items defined, captured, managed, and traceable where changes in one data source alerts owners of other data sources of intended updates
User IF, Viewpoint/Views	N/A	Doc Gen	UI draws from Model app	UI draws from multiple models/DBs	UI supports Interrogation; multiple configs

- Beginning with the "Yardstick" example, one might next work on the "Partial Federated Database Management System (FDBMS)" before the "UI draws from multiple models/DBs," if, as in this example, one assumes that some Federation needs to be in place before the UI can draw from multiple databases.

Potential Uses for Tactical Planning

- Can be partitioned allow different User Roles to focus on their relevant attribute scope and domains
- Helps support rational, practical, defensible decisions regarding where to applied (often limited) resources towards advancing the Stage of Implementation of an attribute(s), e.g.,
  - Further advancement of Attribute A may not be of value or even possible, until Attribute B is first advanced
  - Provides the “Big Picture” to consider a balanced portfolio of advancement activities

Tailoring

- Use language that is important to the organization
  - E.g., NASA uses “project,” DoD uses “Program”
- Identification of individual SE processes to be addressed that are critical to success
  - E.g. CM/DM
- Addition/deletion of rows to focus on organization perspective

Glossary

- TBS